

Title: Integrated Modeling & Simulation Verification, Validation, & Accreditation Strategy for Exploration Systems Mission Directorate, Joe Hale, NASA MSFC

Abstract:

Models and simulations (M&S) are critical resources in the exploration of space. They support program management, systems engineering, integration, analysis, test, and operations and provide critical information and data supporting key analyses and decisions (technical, cost and schedule). Consequently, there is a clear need to establish a solid understanding of M&S strengths and weaknesses, and the bounds within which they can credibly support decision-making. Their usage requires the implementation of a rigorous approach to verification, validation and accreditation (VV&A) and establishment of formal process and practices associated with their application. To ensure decision-making is suitably supported by information (data, models, test beds) from activities (studies, exercises) from M&S applications that are understood and characterized, ESMD is establishing formal, tailored VV&A processes and practices. In addition, to ensure the successful application of M&S within ESMD, a formal process for the certification of analysts that use M&S is being implemented. This presentation will highlight NASA's Exploration Systems Mission Directorate (ESMD) management approach for M&S VV&A to ensure decision-makers receive timely information on the model's fidelity, credibility, and quality.



Exploration Systems Mission Directorate

Integrated Modeling & Simulation

Verification, Validation, & Accreditation

Strategy for Exploration Systems

Mission Directorate

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Verification, Validation and Accreditation

Pre-
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How can you trust the M&S?

Verification

"It works as I thought it would."



Developer
Verification Agent

Validation

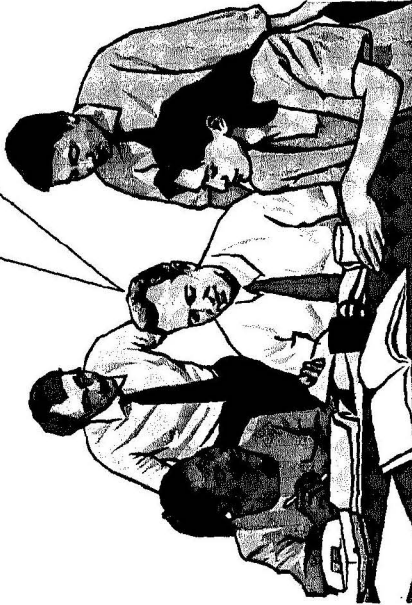
"It looks just like the real thing."



Functional Expert
Validation Agent

Accreditation

"It suits my needs."



Requester/User
Accreditation Agent

As design matures, re-examine basic assumptions

Establish confidence in M&S through VV&A



Definitions (DMSO RPG (additions, my emphasis in blue)

Verification: The process of determining that a model implementation and its associated data accurately represent the developer's conceptual description and specifications.

“Did I build the thing right?”

“Are the equations solved correctly?”

Validation:

The process of determining the degree to which a model and its associated data provide an accurate representation of the real world from the perspective of the intended uses of the model.
[Note: differs from “meeting customer’s expectation”]

“Did I build the right thing?”

“Do I have the correct equations?”

Accreditation: The official certification that a model, simulation, or federation of models and simulations and its associated data is acceptable for use for a specific purpose.

“Should it be used?”

“Should it be trusted?”



How to Validate and Accredited M&S with little or no Real World data?

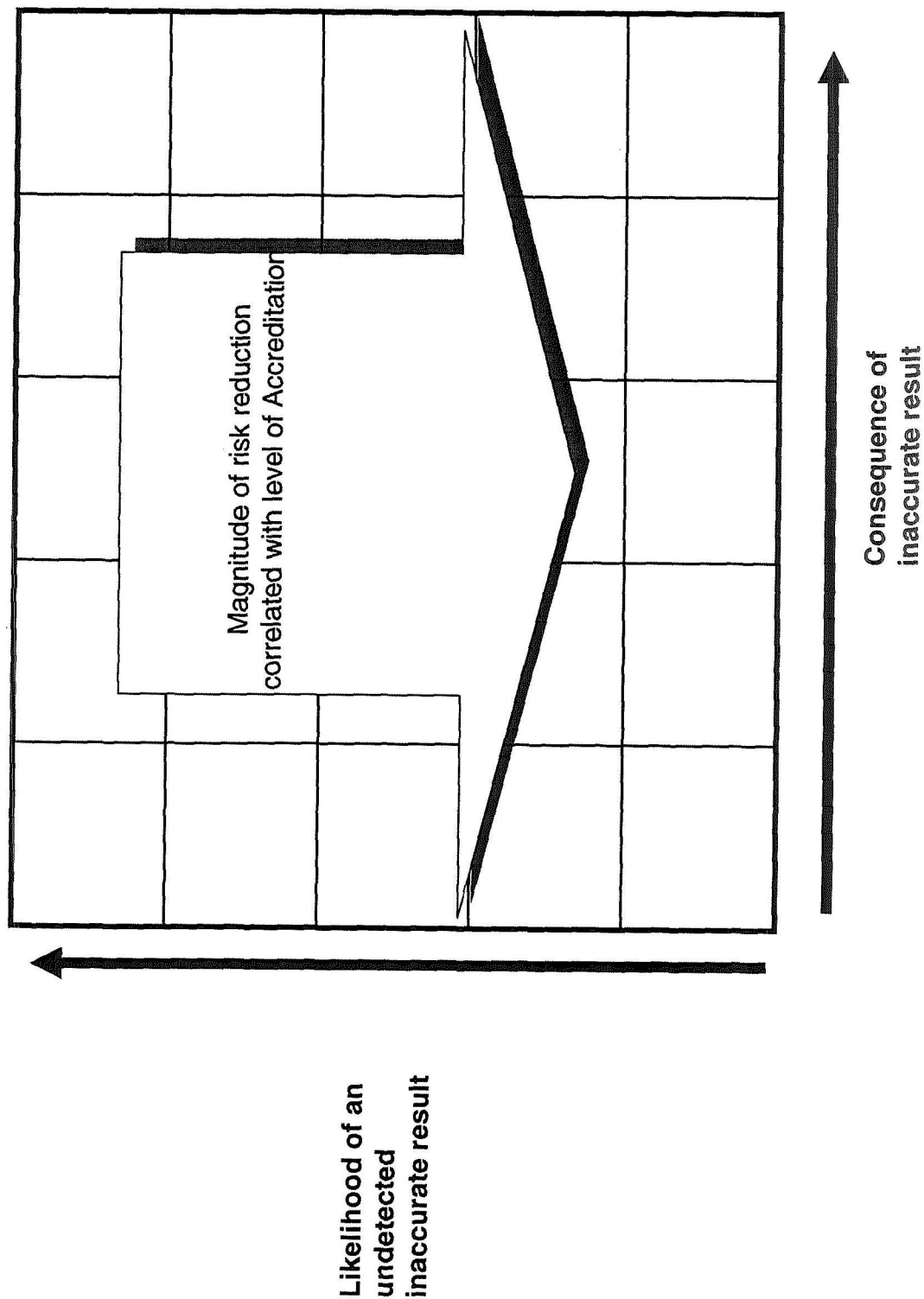
Proposed NASA Approach:

- Adopt a multi-level Accreditation policy
- Determine acceptable Accreditation Level
based on
 - Risk
 - Point in Lifecycle Timeline



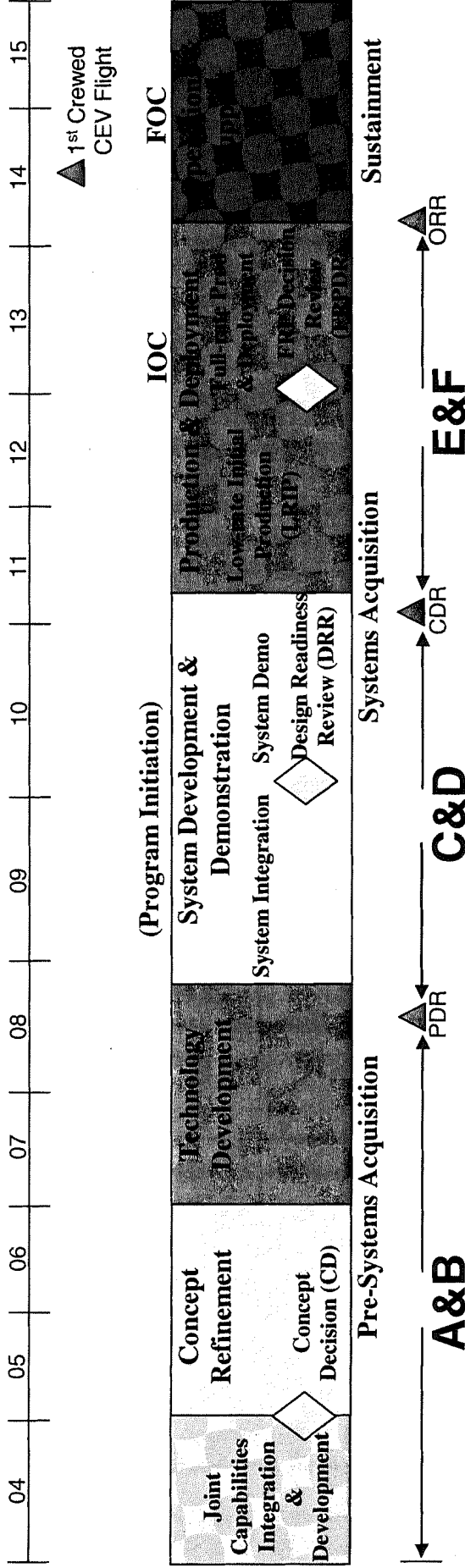
VV&A and Risk

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VV&A And Lifecycle Timeline



Notional VV&A Implementation Phases for Legacy M&S

- A. Govt M&S VVA Level 1
- B. Contractor M&S VV&A Level 0/1
- C. Govt M&S VV&A Level 3
- D. Contractor M&S VV&A Level 2/3
- E. Govt M&S VV&A Level 4
- F. Contractor M&S VV&A Level 3/4



Basis for NASA Approach

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- NASA approach based on the Defense Modeling and Simulation Office (DMSO) Recommended Practices Guide (RPG) and the Joint Accreditation Support Activity (JASA) Accreditation Support Package (ASP)
- JASA provides support for the verification, validation and accreditation (VV&A) of models and simulations used in acquisition programs across the Services



Overview of IM&S VV&A Roles and Responsibilities

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IM&S VV&A TWG

- **Define and maintain** policy guidance and directives for ESMD IM&S VV&A
- **Conduct** VV&A Outreach
- **Assign** VV&A Panel Support
 - **Support** M&S Risk Assessment
 - **Assist** in developing Accreditation and V&V Plans and Reports
- **Develop** Simulation Capability Documentation
- **Concur** on all
 - Accreditation Plans
 - V&V Plans
 - V&V Reports
 - Accreditation Reports
 - Data V&V Reports

User, Accreditation Agent, V&V Agent, SME

- **Support** M&S Risk Assessment
- **Develop** Accreditation Criteria
- **Develop** Accreditation Plans
- **Develop** V&V Plans
- **Develop** V&V Reports
- **Conduct** V&V program
- **Conduct** Data V&V
- **Develop** Accreditation Reports
- **Develop** Accreditation Memoranda



Key Players of IM&S VV&A Process found in next chart (#10)

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Roles	Function
M&S User (Decision-maker)	<ul style="list-style-type: none"> •Identify and defines need for M&S to solve problem or make decision. •Define M&S requirements, •Define Acceptability criteria, •Intended use, •Makes accreditation decision, •Accepts the results.
M&S Accreditation Agent	<ul style="list-style-type: none"> •Conduct accreditation assessment •Provides guidance to the V&V Agent to ensure all necessary evidence is obtain of M&S fitness •Collects and assess the evidence •Provides the results to User •Make accreditation recommendation
M&S V & V Agent	<ul style="list-style-type: none"> •Provide evidence of M&S fitness for intended use by ensuring that all V&V tasks are properly carried out.
SME/TWH	<ul style="list-style-type: none"> •An auxiliary role that contributes to VV&A effort •Recognized authority in specific area or discipline •Help user establish requirement and acceptability criteria •Participate in V&V and Accreditation assessment activities as needed
VV&A Broker	<ul style="list-style-type: none"> •Member of VV&A TWG •Guides, trains, and assists the Accreditation and V&V Agents through the VV&A Process

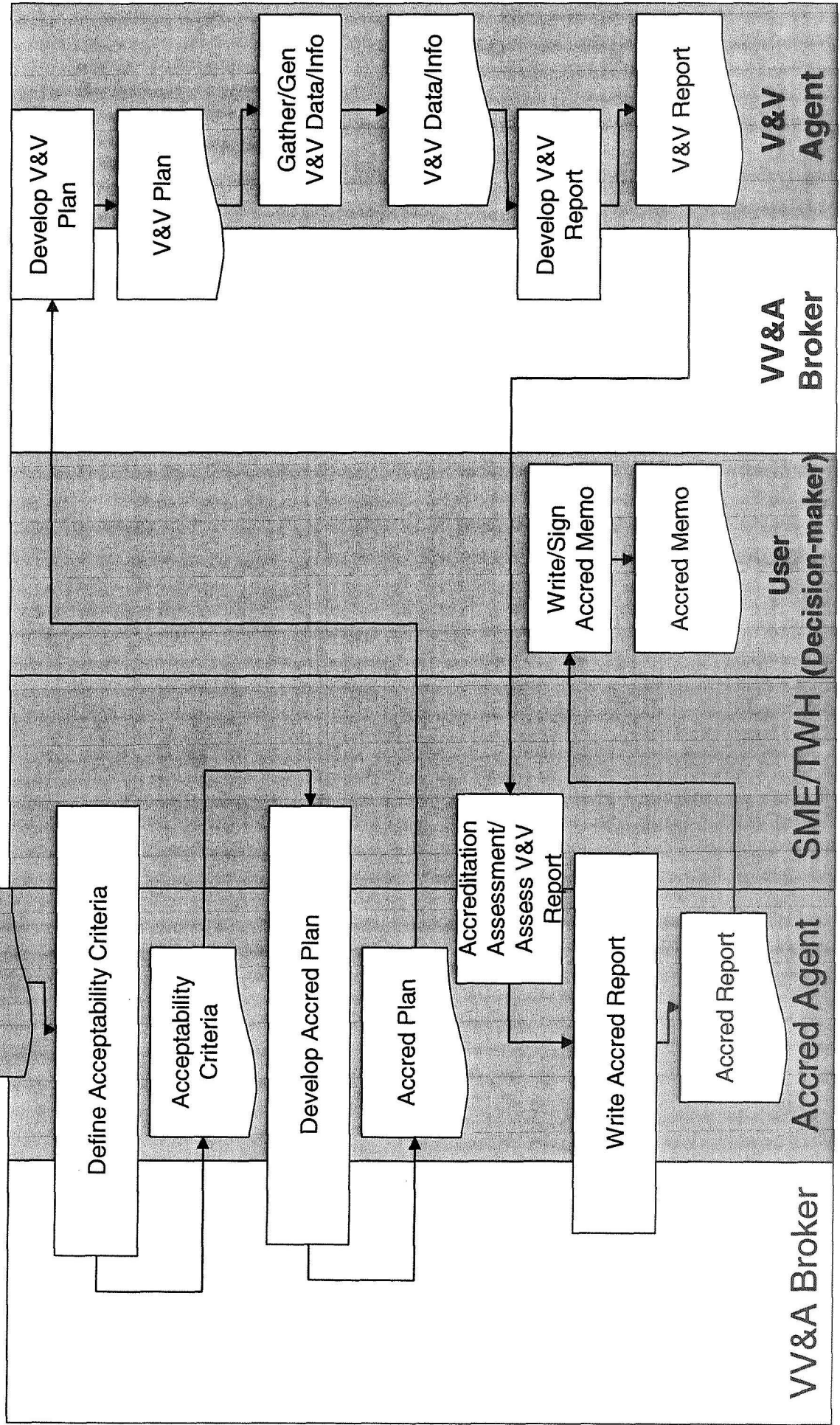


IM&S VV&A Activities and Products Workflow for a Selected Simulation

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Support M&S
Risk
Assessment

Based on DMSO RPG VV&A Profile





IM&S VV&A Roles and Responsibilities Matrix

ROLES/FUNCTIONS									
ACTIVITY	VV&A TWG Lead	VV&A TWG	User	M&S PM/ Proponent	Developer	V&V Agent	Accreditation Agent	SME	
VV&A Policy Development	Lead	Perform	Review	Review	Review	Review	Review	Review	
VV&A Outreach	Lead	Assist							
Risk Assessment ¹		Assist	Lead	Monitor	Assist	Assist	Assist	Assist	
Develop Simulation Capability Document (Basis of Confidence)	Approve	Lead	Assist	Assist	Assist	Assist	Assist		
Define Acceptability Criteria		Assist	Assist	Monitor	Assist	Assist	Lead	Assist	
Develop Accreditation Plan	Concur	Assist	Approve	Assist		Assist	Lead		
Develop V&V Plans ²	Concur	Assist	Review	Assist	Review	Lead	Assist		
Verify & Validate Data	Concur	Review	Approve	Monitor	Assist	Lead		Perform	
Prepare V&V Report	Concur	Assist		Assist		Lead			
Gather Additional Accreditation Info		Monitor	Monitor	Assist		Assist	Lead	Assist	
Prepare Accreditation Report	Concur	Assist	Monitor				Lead	Assist	
Accreditation Decision	Assist		Lead						
Prepare Accreditation Memo	Concur	Assist	Perform				Lead		
Role Definitions									
Lead	Leads the task. Normally involves active participation from others								
Perform	Actually does the task. Normally involves little active participation from others								
Assist	Actively participates in task (e.g., conducting tests, providing information)								
Review	Participation normally limited to reviewing results of task and providing recommendations								
Monitor	Oversees task to ensure it is done appropriately but does not normally participate								
Approve	Determines when an activity is satisfactorily completed and another can begin. Determines what activity should be pursued next (e.g., whether to continue on to the next scheduled activity or to return to a previous activity).								
Concur	Confers when an activity is satisfactorily completed.								

¹ In general, this activity is led by the User in the modification of a legacy simulation and by the M&S PM in new M&S developments.

² This activity is led by the V&V Agent when available and by the User when the V&V Agent is not available at the beginning of the effort.



VV&A Top Level Process

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